

What is claimed is:

1. An array of memory cells with each memory cell formed in and on a semiconductor body having a top surface, each of the memory cells including a vertical field effect transistor having a gate and first and second output regions separated by a channel region and a capacitor formed within a trench in the semiconductor body with a first plate of the capacitor being partially surrounded by an insulating layer and being coupled to the second output region through a strap region with the insulating layer surrounding the first plate on all sides except for a selected portion of just one side of the first plate such that the second output region, which is formed by out-diffusion of impurities from the strap region and the first plate, is limited in lateral extent so as to limit electrical leakage between second output regions of adjacent memory cells.
2. The array of memory cells of claim 1 wherein a cross-section of each trench is a rectangle with a 2:1 aspect ratio.
3. The array of memory cells of claim 1 wherein the cross-section of each trench is one of a group of geometric shapes consisting of rectangles, squares, ellipses, circles, combinations of various curved line segments, combinations of various straight line segments, and combinations of various straight and curved line segments.
4. The array of memory cells of claim 1 wherein each strap region is confined to a small portion of the periphery of a cross-section of said trench such that the second output region is limited in lateral extent so as to limit electrical leakage between second output regions of adjacent memory cells.
5. An array of memory cells with each memory cell formed in and on a semiconductor body having a top surface, with the memory cell including a vertical field effect transistor having a gate and first and second output regions separated by a channel region and a capacitor formed within a trench in the semiconductor body with a first doped polysilicon plate of the capacitor being partially surrounded by an insulating layer and being coupled to the second output region through a doped polysilicon strap region with the insulating layer surrounding the first plate on all sides except for a selected portion of just one side of the first plate such that the second output region, which is formed by out-diffusion of impurities from the strap region and the first

plate, is limited in lateral extent so as to limit electrical leakage between second output regions of adjacent memory cells and the first output region being self aligned to the channel region and to the second output region.

6. A method of forming an array of memory cells with each memory cell fabricated in and on a semiconductor body having a top surface, each memory cell comprising a vertical field effect transistor having a gate and first and second output regions separated by a channel region and a capacitor formed within a trench in the semiconductor body with a doped polysilicon first plate of the capacitor being partially surrounded by an insulating layer and being coupled to the second output region, which is formed by out-diffusion from the strap region and the first plate, through a doped polysilicon strap region with the insulating layer surrounding the first plate on all sides except for a selected portion of just one side of the first plate such that the second output region is limited in lateral extent to limit electrical leakage between second output regions of adjacent memory cells and the first output region being self aligned to the channel region and the second output region, the second output region being formed by out-diffusion of impurities from the strap and first plate regions, starting at a point in which separated trenches have been formed in the semiconductor body and a relatively thin oxide layer has been formed at a bottom surface of each of the trenches and along lower portions of the sidewalls of the trenches which intersect the bottom surface of the trenches and a relatively thick layer of oxide has been formed on the remaining portions of the sidewalls, and the trenches are filled with a first doped polysilicon, the method comprising the step of using shallow trench isolation regions to define the lateral extent of each of the first output regions, and the lateral extent of each of the second output regions, the channel regions and the strap regions.

7. A method of forming an array of memory cells with each memory cell fabricated in and on a semiconductor body having a top surface, each memory cell comprising a vertical field effect transistor having a gate and first and second output regions separated by a channel region and a capacitor formed within a trench in the semiconductor body with a doped polysilicon first plate of the capacitor being partially surrounded by an insulating layer and being coupled to the second output region, which is formed by out-diffusion from the strap region and the first plate,

through a doped polysilicon strap region with the insulating layer surrounding the first plate on all sides except for a selected portion of just one side of the first plate such that the second output region is limited in lateral extent to limit electrical leakage between second output regions of adjacent memory cells and the first output region being self aligned to the channel region and the second output region, the second output region being formed by out-diffusion of impurities from the strap and first plate regions, starting at a point in which separated trenches have been formed in the semiconductor body and a relatively thin oxide layer has been formed at a bottom surface of each of the trenches and along lower portions of the sidewalls of the trenches which intersect the bottom surface of the trenches and a relatively thick layer of oxide has been formed on the remaining portions of the sidewalls, and the trenches are filled with a first doped polysilicon, the method comprising the steps of: etching the first doped polysilicon from an upper portion of each trench down to a level above the thin oxide covering the bottom portions of the sidewalls of the trenches; forming a layer of silicon nitride over the exposed portions of the relatively thick oxide layer and a top surface of the remaining portion of the doped polysilicon; filling portions of the trenches lined with the layer of silicon nitride with a second doped polysilicon; forming shallow trench isolation regions extending from a top surface of the semiconductor body into the semiconductor body to partially define locations therein in which the first output region and the channel region of the transistor and the strap region are to be formed; removing portions of the second doped polysilicon not covered by the shallow trench isolation regions down to the silicon nitride layer formed on the top surface of the previously remaining portion of the first doped polysilicon which forms the first plate of the capacitor to define two sides of the trench, one of which is to contain the strap region and the channel region and a portion of one side of the second output region; forming a mask to define which of the two sides of the trench previously defined will contain the strap region; removing portions of the silicon nitride layer not covered by the mask or by the remaining second doped polysilicon; removing an exposed portion of the relatively thick oxide layer which is on the sidewalls of the trenches down to and below a top surface of the remaining portion of the first doped polysilicon which forms the first plate of each of the capacitors; removing the mask; removing the silicon nitride layer from a sidewall of the trench and a top portion over the remaining portion of the first doped polysilicon which is to become the first capacitor plate so as to expose the thick oxide

layer on a sidewall of the trench; and filling the region of the trench in which the strap region is to be formed with a third doped polysilicon to from the strap region.

8. The method of claim 7 further comprising the steps of: covering a top of the strap region and an exposed top surface of the remaining portion of the first doped polysilicon which forms the first plate of the capacitor with an oxide layer; forming an oxide layer on the exposed sidewall of the trench above the strap region to form a gate oxide; and filling the trench with a conductive material which serves as the gate of the transistor.

9. The method of claim 7 further comprising the step of ion implanting dopant ions into the top surface of the semiconductor body to form first output regions in portions of the semiconductor body not covered by the shallow trench isolation regions, the energy of the ions being sufficient to penetrate the layer of silicon nitride on portions of the top surface of the semiconductor body, but insufficient to penetrate the shallow trench isolation regions on other portions of the top surface of the semiconductor body, said first output regions being of a conductivity type opposite to that of the semiconductor body, and the channel and first and second output regions and the strap regions being all aligned to the shallow trench isolation regions.

10. The method of claim 7 in which the material filling a trench in which a storage capacitor has been formed is patterned and used as an etch mask to define portions of the trench in which the channel region of a transistor and a strap region will be formed.